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THE BELVEDERE EXPEDITION
TO THE GULF OF CALIFORNIA

BY

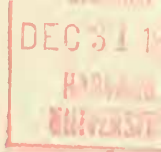
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SAN DIEGO, CALIFORNIA

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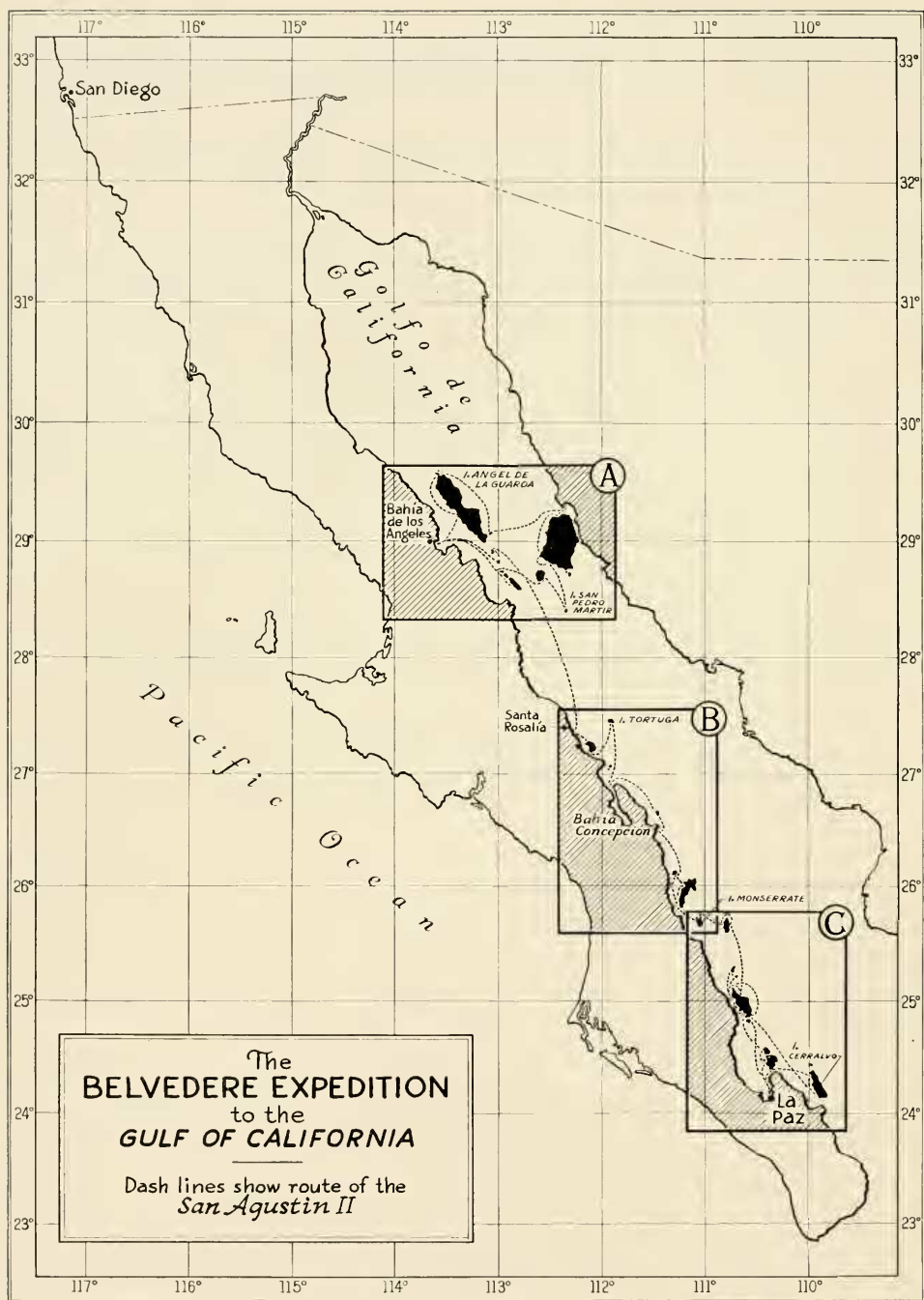


FIG. 1. Route of the expedition. For detail of area A, see page 4; for area B, see page 17; for area C, see page 28.

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INTRODUCTION

The Belvedere Expedition was a voyage for the biological exploration of the islands in the Gulf of California. It was a function of the San Diego Natural History Museum, supported by a grant from the Belvedere Scientific Fund of San Francisco. The "San Agustín II", an eighty-five foot motor vessel with a crew of eight, was chartered for the trip. The owner, Mr. Antero Diaz, accompanied the boat.

Twelve biologists participated, seven for the entire voyage. George Lindsay, as Director of the Museum, was in charge. Ira L. Wiggins, Professor of Biology at Stanford University and Scientific Director of the Belvedere Scientific Fund, made general botanical collections, as did Reid Moran, Curator of Botany of the Museum. Richard C. Banks, Curator of Birds and Mammals, collected birds and mammals. Charles F. Harbison, Curator of Entomology, collected land arthropods. William K. Emerson, of the American Museum of Natural History, collected fossil and recent invertebrates. Charles Shaw, Assistant Director and Curator of Reptiles of the San Diego Zoo, collected reptiles with the assistance of Michael Soulé, a graduate student at Stanford University. Don Hunsaker II, Assistant Professor of Zoology at San Diego State, Dennis Bostic, his graduate student, and Chris Parrish, Museum Assistant and student at San Diego State College, joined the expedition at La Paz for eight days during their spring holiday. Ambrosio González C., Jefe de Investigadores of the Instituto Mexicano de Recursos Naturales Renovables, was with the expedition from March 14th through April 3rd.

The "San Agustín II" sailed from Bahía de los Angeles March 15th, 1962, and returned April 26th. During the voyage, 32 islands were visited, with several stations on each of the larger ones. A stop was made at Punta Sargento, Sonora, and there were seven stations along the Baja California coast.

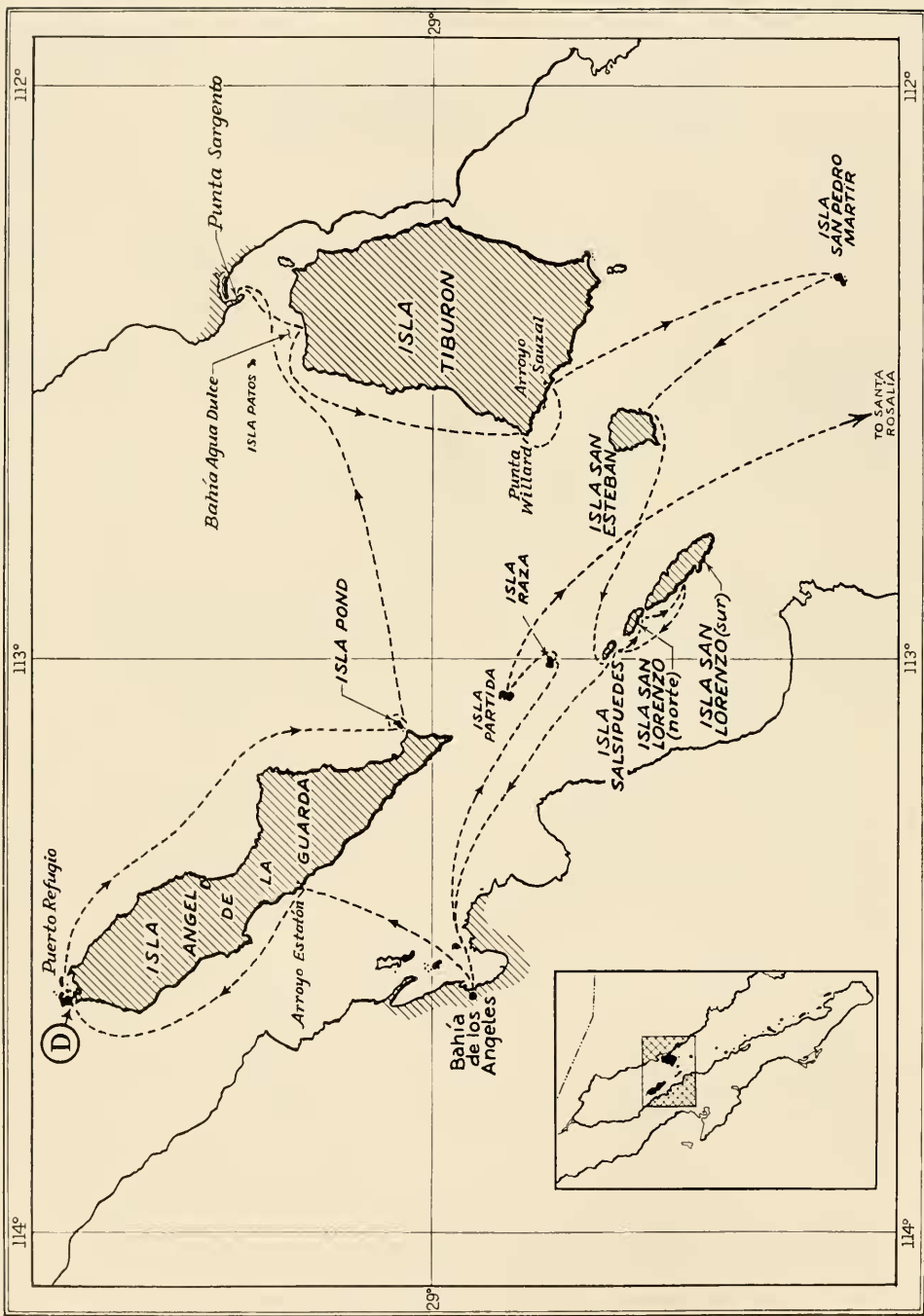


FIG. 2. North Gulf islands, the route of the expedition shown by a dash line. For detail of area D, see page 8.



Fig. 3. The "San Agustín II", the eighty-five foot motor vessel chartered for the expedition.

LOG OF THE EXPEDITION

Wiggins and Soulé were the first to leave San Diego, taking a load of expedition gear in the International Travelall of the Belvedere Scientific Fund. They left March 11th and arrived at Bahía de los Angeles March 13th. González, Emerson, Moran, Banks, Harbison, Shaw, and Lindsay flew from Tijuana to Bahía de los Angeles the morning of March 14th, arriving at 1105. All hands spent the afternoon getting the equipment and supplies aboard the "San Agustín II".

March 15: Bahía de los Angeles to Puerto Refugio, Isla Angel de la Guarda.

We breakfasted ashore, got the last gear aboard, and departed from Bahía de los Angeles at 0900, en route to Isla Angel de la Guarda. The crossing was choppy, and there was a cold wind. The first stop was at Arroyo Estación, at 1200.

Angel de la Guarda is 47 miles long — the longest island in the Gulf — and 12 miles wide in the south-central part. It has a peak 4315 feet high in the northern section. The upper part of the island is composed of volcanic rocks, resting on a basement of granitic and metamorphic rocks, which are exposed at several localities. The flora includes the elephant tree (*Pachycormus discolor*), cardon cactus (*Pachycereus pringlei*), and other plants of the central desert flora of Baja California. Angel de la Guarda is uninhabited.



FIG. 4. Biologists of the expedition. Upper row, left to right: Richard C. Banks, Michael Soulé, Don Hunsaker II, Chris Parrish, Ira L. Wiggins, Charles Shaw, Reid Moran. Lower row: William K. Emerson, Dennis Bostic, Charles F. Harbison. Behind the camera: George Lindsay. Back in Mexico City: Ambrosio González C.

We were pleased, when we went ashore at Arroyo Estación, to find the island relatively moist, and many plants in flower. Lindsay climbed a ridge to where a Museum party had collected two giant rattlesnakes (*Crotalus mitchelli* ssp.) in 1960; he found no more snakes but did recover a geologist's hammer left at that time. All were aboard at 1500, and we went to Puerto Refugio, where we found a good anchorage between Isla Mejía and the main island. Harbison spent the night ashore to collect insects with gasoline lanterns; Banks set small mammal traps.

March 16: Puerto Refugio, Isla Angel de la Guarda.

Shore parties worked Isla Mejía and Angel de la Guarda. Shaw, Soulé, González, Emerson and Lindsay checked reptile traps left by John Sloan in August 1961. These were five-gallon cans sunk level with the soil surface and covered with masonite tops but with space for reptiles to enter. The first trap, in a dune area, had filled with sand; but the others, placed in rocky situations, contained many lizards, rodents, scorpions, and insects. These were removed for shipment to Sloan in San Diego.



FIG. 5. Michael Soulé and Charles Shaw removing specimens from a reptile trap at Puerto Refugio, Isla Angel de la Guarda.



FIG. 6. Charles Shaw and a friend, a large black chuckwalla (*Sauromalus hispidus*), at Puerto Refugio, Isla Angel de la Guarda.

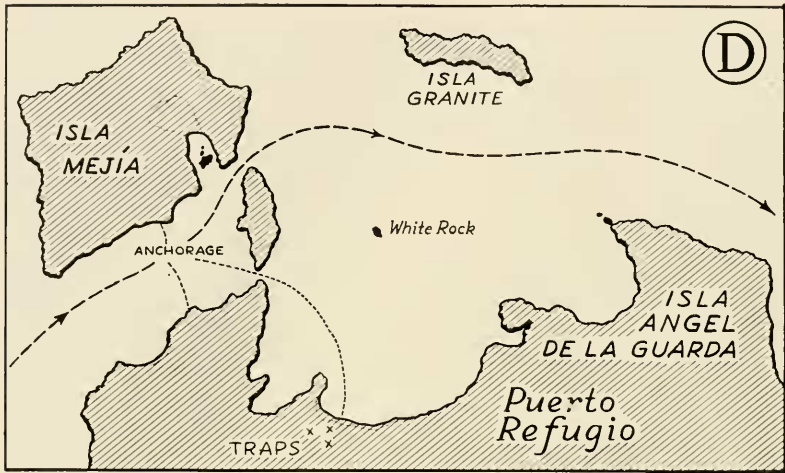


FIG. 7. North end of Isla Angel de la Guarda.

The botanists found collecting good, and there was a fine display of wildflowers. Among several new records was *Phacelia pauciflora*, a rare plant known only from a few collections from the vicinity of Bahía de los Angeles but not known from any of the islands.

We made a special effort to collect scorpions on each of the islands and did so without exception. At Puerto Refugio we were surprised to find many small scorpions under rocks in the upper littoral zone: five were collected under a single beach boulder. They were in sand moist with sea water, in an area subject to inundation at extreme high tide. Apparently they are an undescribed *Vejois* known also from Bahía de los Angeles.

Large black chuckwallas (*Sauromalus hispidus*) are abundant on Isla Angel de la Guarda, and a series of living ones was taken for the San Diego Zoo. One specimen of speckled rattlesnake (*Crotalus mitchelli*) was collected.

March 17: Puerto Refugio to Pond Island, Isla Angel de la Guarda.

We were under way at 0700, coasting down the east side of Angel de la Guarda to Pond Island. Because it is supposed to be crawling with rattlesnakes, Pond Island is known locally as Isla Vibora; and it did yield one specimen of red rattlesnake (*Crotalus ruber*), for a new record.

Pond Island is only about one mile long and 400 feet high. It is connected to Angel de la Guarda by a rocky reef which dries in places at low water. Wiggins, Banks, Soulé, González, Shaw, and Lindsay spent the afternoon on Pond; Moran and Harbison went to the main island near Pond Island Bay; and Emerson took

a small boat down the coast about two miles to sample some fossil deposits. Banks collected a nesting Craveri's murrelet (*Endomychura craveri*) for a new breeding station. An attractive lagoon at Pond Island has a prolific fauna. Emerson returned to collect there; and Díaz turned malacologist to the extent of collecting two sacks of large rock oysters, which we had steamed at cocktail time and fried for dinner. We enjoyed a comfortable anchorage south of Pond Island.

March 18: Pond Island to Punta Sargento, Sonora, and Bahía Agua Dulce, Isla Tiburón.

We were under way at 0330 on the fifty-mile run to Punta Sargento, through flat calm water. We changed course several times to photograph finback whales, about 25 of which were observed off the west side of Isla Tiburón. Near Isla Patos the sea was covered by feeding Bonaparte's gulls, dainty birds which pick macroplankton from the water as they swim or hover. There were also many terns, loons, cormorants, and pelicans. A long line of flying pelicans had three blue-footed boobies in formation, a situation we were to observe often.

Shoal water near Punta Sargento made it necessary to anchor a mile offshore. We landed at a campsite, apparently deserted, but a canoe with three young Seri Indians, two men and a woman, approached evidently expecting to land. Seeing us, they changed course and went around the point. We found a tremendous midden just above the beach, a yard thick and hundreds of yards long.



FIG. 8. Reid Moran collecting plants at Puerto Refugio, Isla Angel de la Guarda.



FIG. 9. Ambrosio González C. examining a sour pitahaya plant (*Machaerocereus gummosus*) at Punta Sargento, Sonora. This cactus had not been known to occur on the Mexican mainland.

One reason for visiting Punta Sargento was to verify the occurrence there of the sour pitahaya (*Machaerocereus gummosus*), seen from the air in December 1960. The cactus was thought to be endemic to Baja California and the Gulf islands and not known to occur on the Sonora mainland. We found the sour pitahaya in abundance, as well as a tuberous-rooted cactus (*Wilcoxia diguetii*).

The shore party returned to the ship at 1200; and we went to Isla Tiburón. Tiburón is the largest island in the Gulf of California, 30 miles long and 20 miles wide, the only large island on the eastern side of the Gulf. The highest range in the eastern margin rises to nearly 4000 feet. The island is separated from Sonora by a shallow, narrow strait, 2 to 4 miles wide and in places less than 20 feet deep.

We spent the afternoon collecting at Bahía Agua Dulce, at the north end of Tiburón. Crucifixion thorn (*Koeberlinia spinosa*) was found here for the first insular record. Four canoe loads of fishermen were camped on shore, their camp surrounded by drying shark meat. Harbison went ashore for the night, to collect insects.

March 19: Bahía Agua Dulce to Punta Willard, Isla Tiburón.

A brisk offshore breeze held us sideways to the swell, causing a heavy roll and a confusion of fallen books, boxes, and gear in the cabin. The plant drier secured to the cabin roof, used heat lamps run by the main generator. The drier was covered with a tarp at night after the generator was shut down, to protect the plant presses from dew. When the engineer started the main generator at 0430, no one thought to remove the cover from the plant presses, and the whole thing burst into flame about 0600. There was much excitement as crewmen threw burning tarpaulins, corrugates, and specimens into the sea. The previous day's plant collections were lost.

We were under way down the west coast of Tiburón at 0800. Many birds and several whales were observed. Anchoring at Punta Willard at 1100, the shore party worked until 1430, when a sudden shower sent everybody aboard. Díaz and a crewman, José Toledo, went hunting and returned with a nice little mule deer (*Odocoileus hemionus sheldoni*), which is endemic to Tiburón. Banks supervised skinning and kept the skin and skull for a specimen. Three shrimp trawlers passed and anchored under the point in the evening.

March 20: Punta Willard to Sauzal, Isla Tiburón.

We were under way soon after 0400 and anchored off Arroyo Sauzal, on the south side of Tiburón, at 0600. Shrimp boats anchored nearby supplied us with fresh shrimp and agreed to take mail to Guaymas. José Toledo brought aboard some antelope jack rabbits (*Lepus alleni tiburonensis*), one of which was alive and looked strange indeed, hopping about the deck.

Two new reptile records were obtained on Isla Tiburón: Harbison found a Sonora boa (*Lichanura trivirgata*); and Soulé collected a Sonoran gopher snake (*Pituophis catenifer affinis*).

March 21: Isla Tiburón to Isla San Pedro Mártir and Isla San Esteban.

The trip from Isla Tiburón to Isla San Pedro Mártir was calm. San Pedro Mártir is a triangular rock mass 1052 feet high and less than a mile wide, lying in mid-Gulf. It apparently is rhyolite. Being the nesting place of thousands of blue-footed and brown booby birds, it is almost entirely covered with guano. Brown pelicans also nest on the island, and red-billed tropic birds were observed flying above.

We anchored in a small cove on the northeast side. Guano was collected commercially in the past, and many stone terraces and platforms for its accumulation remained on the steep slopes. Large iron rings attached to rocky cliffs apparently were used to hold lighters at the small shingle beach where we put ashore. California sea lions were tame and played about the shoreboats.

Two large dark endemic lizards (*Uta palmeri* and *Cnemidophorus tigris martyris*) were very abundant over the whole island, even foraging on the algae-covered rocks of the intertidal zone. They were not timid, and many were taken



FIG. 10. Blue-footed boobies (*Sula nebouxii*) on Isla San Pedro Mártir.

alive without difficulty. The only snake known from Isla San Pedro Mártir is a large rattlesnake (*Crotalus atrox*), a single specimen of which was taken by Reid Moran in 1952. Our party collected seven additional examples of this large rattlesnake, which will make possible a more critical taxonomic study.

The upper part of Isla San Pedro Mártir was covered with a bright globe-mallow (*Sphaeralcea hainesii*) in full bloom, forming a colorful understory of a fine forest of *Pachycereus pringlei*. The biologists returned to the beach at noon, rather reluctant to leave this interesting island. Collections were processed on the three-hour run to Isla San Esteban, where we anchored off the mouth of a broad arroyo on the southeast side, just north of an offlying rock.

Isla San Esteban is about 4 miles long north and south, 3 miles wide, and 1772 feet high. Tidal currents are very fast, and tide rips cause broken water during the most rapid flow. A low shingle spit projecting about $\frac{3}{4}$ mile from the southwest end of the island, is the nesting place of western gulls. Osprey nests occupied the tops of most pinnacles and cliffs.



FIG. 11. Ira L. Wiggins with a large rattlesnake (*Crotalus atrox*) which he collected on Isla San Pedro Mártir.

March 22: Isla San Esteban.

The whole day was spent at the same anchorage. Moran climbed to the top of the island and found particularly good collecting on north slopes, adding many species to the known flora. Interesting finds included a crucifer (*Lyrocarpa linearifolia*) previously known only from one collection from Angel de la Guarda and an ironwood (*Sideroxylon leucophyllum*) known from no other island but Angel de la Guarda. Harbison and Moran saw racers which they were unable to collect. A large pink-and-brown blotched chuckwalla (*Sauromalus varius*) and another large lizard (*Ctenosaura hemilopha conspicuosa*) inhabit the rocky arroyos and slopes. A series of living specimens was taken for the San Diego Zoo. An endemic blacktailed rattlesnake, only three specimens of which have been taken, was not found by our party.

A large hedgehog cactus (*Echinocereus grandis*) was in flower, as were an as-yet-undescribed species of *Mammillaria* and a cholla cactus. Emerson found a Pliocene outcrop just north of the anchorage, from which he collected echinoderm spines, oysters, and corals. Diaz, while fishing for the galley, caught a large garoupa. Scorpions (*Hadrurus* sp. and *Centruroides exilicauda*) were fairly abundant but small.

March 23: Isla San Esteban to Isla Salsipuedes.

A strong west wind came up during the night, but our anchorage was protected. Banks and Wiggins went ashore with the boat that picked up Harbison, who had collected insects during the night. We were under way about 0700. The wind continued fresh, and the crew took unusual precautions, stowing all gear below and even removing the plant presses from the cabin top. We learned why when we cleared the protection of Isla San Esteban, en route to Isla San Lorenzo. The Gulf was rough, and spray flew the length of the boat. We changed course for Isla Salsipuedes and reduced speed. Arriving at a good anchorage in a cove in the southwest side of that island about 1045, we had an early lunch, and were ashore before noon.

Isla Salsipuedes, Isla San Lorenzo Norte (called Isla Partida by the Mexicans), and Isla San Lorenzo Sur form the eastern side of the Canal de Salsipuedes. They are long narrow islands, the southeastern end of the same ridge whose northwestern end is Isla Angel de la Guarda. The shoreline of the islands is bold, and there are few places to land. Isla Salsipuedes is about 1½ miles long, ½ mile wide, and 376 feet high, with several offlying rocks. The island is barren and monotonous, and the continuing strong wind made collecting difficult.

March 24: Isla Salsipuedes, Isla San Lorenzo Norte and Isla San Lorenzo Sur.

The wind abated during the night. We went to the south end of Isla San Lorenzo Norte and landed at the mouth of a steep arroyo. Emerson worked a small lower Pliocene sandstone deposit, while the others climbed to the top of the island. Banks caught a deer mouse (*Peromyscus guardia*) by hand, for the first record for the island. Pelicans were nesting in the arroyo bottom. Some of the eggs made noises, and in other nests the ugly little plum-colored, hiccuping



FIG. 12. Isla San Lorenzo Sur, as seen from Isla San Lorenzo Norte.

chicks had hatched. The giant hedgehog cactus, endemic to San Esteban and the two San Lorenzos, had golden colored spines and rather pink flowers. A finback whale passed while we were ashore. Unusually beautiful specimens of chalcedony scattered over the top of the island inspired some of the biologists to become rockhounds. Vegetation was sparse.

Returning to the ship at midday, we sailed to the mouth of an arroyo about one-third the way down the west side of Isla San Lorenzo Sur. The vegetation was much more interesting and included the wild fig tree (*Ficus palmeri*), *Galvezia*, *Bursera*, and *Pachycereus*. There were tremendous deposits of gypsum, forming cliffs and vertical walls of the narrow canyon in which we worked.

Returning to the ship at 1630, we sailed to the Salsipuedes anchorage for the night. Americans in a sportfishing boat, who had come from Bahía de los Angeles, were unable to return because of rising wind and seas and so stayed aboard our ship.

March 25: Isla Salsipuedes to Bahía de los Angeles.

Our schedule called for a stop at Isla Raza; but since the rough seas precluded landing there, the small boats were put aboard and we headed for Bahía de los Angeles, where we arrived at 1245. An inspector from the Mexican Fisheries Department was there to see the Vermilion Sea Field Station, and we

needed water and fresh supplies. Lindsay left the expedition for six days, returning to San Diego by air and rejoining the boat at Mulejé on March 31st. The biologists spent the afternoon ashore, boarding after dinner for an early departure the following morning.

March 26: Bahía de los Angeles to Isla Raza and Isla Partida.

The crew were aboard at 0330, the engines started at 0415, and we were under way at 0500. We visited Isla Raza first to take advantage of the calm sea, because landings are difficult in rough weather. It is a small island, only $\frac{3}{4}$ mile long east and west, $\frac{1}{2}$ mile wide, and 100 feet high, and is the nesting place of thousands of Heermann's gulls. These trim dark gray birds with white heads and red bills occupied the whole island but had not yet started to lay. Commercial eggers had come from Santa Rosalía by canoe and were waiting for the birds to produce. Royal terns chattered and scolded at the water's edge, where they were confined by the Heermann's gulls; they would later establish nesting colonies near the north end of the island.

Raza is another island where guano was formerly harvested commercially. The flat areas are cleared of rocks, which are stacked in great piles, to facilitate guano collecting.

We departed at 1350 on the one-hour run to Isla Partida. Partida is $1\frac{1}{4}$ miles long and $\frac{1}{2}$ mile wide and consists of two peaks about 400 feet high joined by a low narrow isthmus. Anchorage was made in a little cove on the east side.

Botanical collecting was poor. Emerson worked on a Pliocene deposit on the south side of the isthmus, collecting pectens, barnacles, and oysters. Banks caught five fish-eating bats (*Pizonyx vivesi*) under the loose rocks of a talus slope. Two of them bit him. These curious mammals apparently feed almost exclusively on small fish, which they catch with their long feet and long compressed claws. Black petrels, too, nest under the talus rocks, and one flew aboard at night while we were at anchor.

March 27: Isla Partida to Santa Rosalía.

Banks and Harbison were picked up at 0500. Harbison amused and amazed the crew by letting a large tarantula, which he found on Isla Partida, walk over his arm. The whole day was spent on the run to Santa Rosalía, where the ship was moored to the dock at 1930.

March 28: Santa Rosalía to Isla San Marcos.

We stopped at Santa Rosalía because of a radio message from San Diego that a biologist from the University of Mexico would join the expedition there. We stayed in Santa Rosalía until the arrival of the Aeronaves plane; but the scientist was not aboard, so we sailed to Isla San Marcos. San Marcos is almost 6 miles long and $2\frac{1}{2}$ miles wide; its highest peak is 891 feet. Most of the island is volcanic, but there are large lower Pliocene deposits of fossiliferous marine sediments and gypsum at the south end. The gypsum beds are about 400 feet thick where they are quarried on the southwest side of the island. The gypsum apparently accumulated in an ancient saline lake or lagoon.

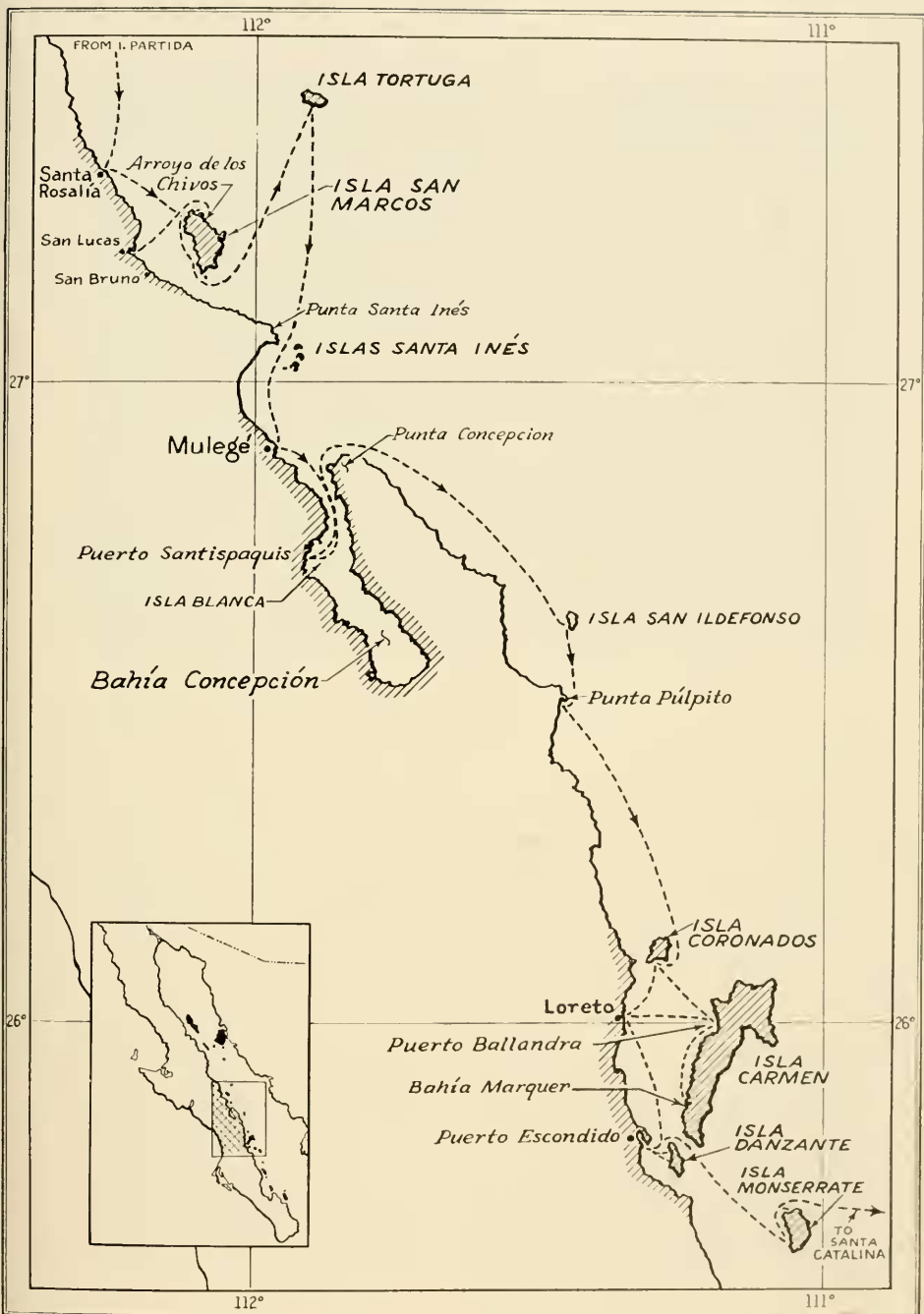


FIG. 13. Central Gulf islands, the route of the expedition shown by a dash line.

We landed at 1430 on the northwest coast for 3½ hours' collecting. Leaving Harbison to camp on the beach, we moved south to the village to anchor for the night.

March 29: Isla San Marcos to San Lucas and return.

Six biologists were left on the east side of Isla San Marcos, about three miles from its northern end, while the ship took Wiggins to the San Lucas airstrip to meet a plane from Guaymas. The biologist was not aboard, and the ship returned to Isla San Marcos and picked up the shore party in the evening, proceeding to the village to anchor for the night.

March 30: Isla San Marcos to Isla Tortuga and Mulejé.

We were under way at 0415, landing on the middle of the south side of Isla Tortuga at 0800. Tortuga is a barren and precipitous island about two miles long and one mile wide, the top of a huge volcanic mountain, composed of recent-appearing dark lava, with a crater about 200 feet deep and half a mile across.

Tortuga was very dry, and the botanists had rather poor collecting; but on one parched slope Moran was amazed to see lush green moss growing under a rock. When he reached to collect a sample, he felt warm moist air, from a small fumarole. The island still has central heating.

A small endemic rattlesnake (*Crotalus tortugensis*), was fairly abundant, and the herpetologists had good collecting. Harbison found many insects, in spite of the dry condition.

Departing from Isla Tortuga at 1430, we went toward the Islas Santa Inez, three low barren islands surrounded by shoals and sunken rocks. The sea was uncomfortable, the islands offered little protection, the time was late, and the biologists were not particularly interested in going ashore. It was decided to proceed to Mulejé through the shallow passage between the islands and Punta Santa Inez. We anchored at 1945.

March 31: Mulejé to Puerto Santispaquis, Bahía Concepción.

The "San Agustín II" rolled heavily during the night in the exposed anchorage at Mulejé. We moved closer to the beach after daylight, and the biologists worked ashore from 0800 until 1230. Mr. and Mrs. Lawrence Kuebler flew over the ship at 1245, bringing Lindsay from San Diego. Díaz met them at the Rancho Loma Linda airstrip when they landed, and brought them aboard about 1300. The Kueblers visited the ship for a short time, then went ashore loaded with boxes of specimens and mail, which they took back to San Diego next day. We cruised to the beautiful Santispaquis Cove on the western shore of Bahía Concepción, anchored, and went ashore in the evening. Harbison spent the night ashore, and Soulé hunted reptiles with the gasoline lantern.



FIG. 14. Baby pelicans (*Pelecanus occidentalis*) on Isla Blanca, Bahía Concepción.

April 1: Puerto Santispaquis.

Wiggins, Banks, and Lindsay worked some of the islets near the anchorage, the most interesting of which was Isla Blanca. Pelicans were nesting on the ground and in palo-verde trees, some of which bore white stalactites of guano. Blotched solitary eggs of oystercatchers lay in very slight depressions in the beach gravel. Western gulls also were nesting along the beach, but they did use a few twigs and bits of seaweed to house their eggs.

Everybody but Moran returned to the ship at noon. Two American couples who were camped ashore, joined us in a big turtle barbecue. A turtle had been split and the halves of the shell propped on either side of a small fire to cook. Whole yellowtail and cabrilla were roasted on coals. Clams from a beautiful little lagoon were also toasted on coals. The campers brought cocktails of hacha, and sabichi, a raw fish cocktail made of sierra mackerel. Cold beer was from our cold room. It was a beautiful day and a pleasant party. Moran returned to the beach and was picked up just at dark. Many man-of-war birds circled and spiralled at great altitude in the evening sky.



FIG. 15. William K. Emerson collecting fossils from a large Pliocene bed at El Pulpito, Baja California.

April 2: Bahía Concepción to Isla Ildefonso and El Púlpero.

The engines started at 0330, and an outboard stuttered toward shore to pick up Harbison, who had started his lantern to guide it in. The anchor was up at 0400, and we had a very smooth passage to Isla Ildefonso, arriving at 0800. The island is a little more than one mile long, perhaps half a mile wide, and 387 feet high. The top is a rather flat tableland. We anchored and landed in a cove at the south end. Pelicans had finished their nesting, but there were many blue-footed and brown boobies with eggs or chicks. Two large finback whales cruised along the island in fairly shallow water.

Boarding at 1230, we lunched during the six-mile run to Punta Púlpero. Anchoring about half a mile south of that great volcanic plug, which is 500 feet high, we went ashore for the afternoon. Emerson, Wiggins, and Lindsay collected fossils from a large Pliocene bed just above the water line. Soule and Banks found two rattlesnakes (*Crotalus ruber*). Harbison again spent the night ashore.

April 3: El Púlpero to Isla Coronados, Loreto, and Coronados.

Juan Largo took Banks ashore to pick up his traps, and they brought Harbison aboard. We departed at 0630 on the three-hour run to Isla Coronados, another volcanic island. It is about $1\frac{3}{4}$ miles long, north and south, $1\frac{1}{2}$ miles wide, and 928 feet high. The island is covered with boulders of volcanic rock, which make walking difficult; and the crater is a Pleistocene andesite volcano. The biologists were put ashore near the base of a sand and rock spit, at the south end of Los Coronados, and Wiggins and Moran went to the top. The ship proceeded to Loreto. There Mr. González left the expedition, to go to the United States and visit museums and herbaria in connection with his current study of the platypuntia cacti. We checked with the Captain of the Port for our mail and papers and found no word from the biologist. A canoe brought several drums of fresh water to the ship. We left at 1445, reaching Los Coronados at 1545, and anchored for the night.

Several large scorpions including an undescribed *Hadrurus* 14 cm. long, were taken under rocks and rotting nets at deserted shark fishing camps.

April 4: Isla Coronados to Isla Carmen.

Isla Carmen is about 18 miles long and 2 miles wide except at the northern end, where it widens to 5 miles. The taller mountains west of Salinas Bay rise to an elevation of 1572 feet. A permanent spring supplies water to a large salt works at Salinas Bay. The salt deposit is about $1\frac{1}{2}$ miles long and 1 mile wide. The vegetation of Carmen is heavier than that of the more northern islands.

We anchored in Puerto Ballandra, on the northwest side of Carmen, at 0800. This is a beautiful circular cove, with a narrow entrance between high headlands. There is a small lagoon with mangroves behind the bay, and a wide arroyo gives access to the central part of the island. In an interior valley on the trail to the salina are a dry well and a stone pumphouse, said to have supplied



Fig. 16. A Pliocene coral reef at Puerto Ballandra, Isla Carmen.



Fig. 17. Well preserved coral (*Porites californica*) in the fossil reef shown above.

water for mules when salt was packed to Puerto Ballandra for shipment. Moran climbed the peak overlooking the salinas. One of the interesting finds here was the dormant bulbs of a zephyr lily (*Zephyranthes arenicola*), which later flowered in San Diego. Moran got it again on Isla Catalina.

Emerson found a fossil reef with beautifully preserved coral heads at the south end of the bay. D'az and one of the crewmen, José Toledo, drove the Pak-Jak, a motor-driven field scooter, across the island to the village at the salt works, no doubt the first trans-island trip by a wheeled vehicle. In the evening a gasoline lantern was suspended over the water, attracting larval fish, marine worms, and other organisms. The engineer, impressed with the results, made an electrical extension light to hang over the side.

April 5: Puerto Ballandra to Bahía Marquer and return.

Banks got nine mammals in his 43 traps during the night. Harbison's insect collection was good. After the two were picked up, we cruised to Bahía Marquer. This is the type locality of the Marquer formation of an upper Pliocene calcareous conglomerate containing volcanic pebbles, sandstones, algal limestone, and coral reef material. Fossils were abundant throughout the high cliffs but were badly leached.

South of Bahía Marquer at about 50 meters elevation Moran was surprised to find a small dry lake with two partially aquatic plants (*Eryngium nasturtii-folium*, *Marsilea fourmieri*) not reported before from any of the islands.

Shaw and Lindsay went up a narrow arroyo in whose limestone bottom were several tinajas with damp sand and some water. Turning over several hundred rocks they got only two scorpions (*Centruroides exilicauda*) but collected a worm snake (*Leptotyphlops* sp.) and a black headed snake (*Tantilla* sp.), both new records for the Gulf islands. We returned to Puerto Ballandra for the night.

The new night light was put over, and soon a great quantity of fish, attracted by the swimming organisms, were darting through. Then a large green turtle swam up and was promptly speared by Juan Largo.

April 6: Puerto Ballandra to Loreto and Puerto Escondido.

Early in the morning we went to Loreto, where Díaz had arranged for diesel fuel to be brought out with small boats. Rough water in the open roadstead made loading a tricky operation. Various supplies, including fresh tomatoes, a goat, live chickens, and a live turtle, were loaded the same way. Shaw, Banks, Harbison, and Soulé took a car to San Telmo, a pool on the road to Parras, to collect tree frogs (*Hyla regilla*) for David Jameson of San Diego State College. They were unable to find the frogs but did collect one tadpole. The rest had lunch and showers at the Garayzars, mailed letters, and picked up mail and ship's papers from the Captain of the Port; and then we all departed for Puerto Escondido.

Puerto Escondido is a beautiful little harbor, perfectly landlocked. Formerly, the bay was a strait between the peninsula and two small islands, but a

low tombolo has connected the islands and the peninsula at the northern end. The very narrow entrance to an inner harbor is kept open by rushing tidal currents. Tremendous rugged cliffs of the Sierra Giganta form a spectacular back-

We anchored south of the entrance of the inner harbor, and Wiggins, drop for the bay.

Moran, and Harbison went ashore in a mangrove area to the east. Moran found a specimen of *Crotalus ruber lucasensis*. Emerson, Soulé, and Lindsay surveyed the inner harbor and at its northern end found an unusual chocolate-brown scorpion with cream-colored legs.

April 7: Puerto Escondido to Isla Danzante and return.

We breakfasted on the short run to Danzante, where we anchored in a protected cove on the western side near the north end. Danzante is a rough island about $3\frac{1}{2}$ miles long and less than a mile wide, composed of Comodú volcanics. From the air it looks like a dinosaur. There were pelicans nesting at the north end of the island. A dead yellow-bellied sea snake (*Pelamis platurus*), was found on the beach. Moran and Wiggins more than tripled the known flora of the island.

Moran needed the full day for botanical collecting on Danzante, while the rest wanted to work the peninsula at Puerto Escondido. Arrangements were made for a small boat to pick Moran up at 1630, and the ship returned to Puerto Escondido at noon. A native named Ramón Villalejo reported frogs in a tinaja called Carrizal, which he stated was but two kilometers distant. He agreed to guide Shaw, Soulé, Wiggins, Harbison, Banks, and Lindsay to the tinaja. We started in boats which deposited us at a trail to the north end of the inner harbor, then we walked over a low pass and down a beach to a grove of date palms called Chenque. There Banks shot a red fox which was eating a kid, and Shaw found a banded burrowing snake (*Chilomeniscus* sp.) under a rock. Ramón thought it was dangerous and was very concerned when Shaw picked it up. We had already hiked much more than two kilometers when we turned inland for the longer walk to the base of the Sierra Giganta. We finally reached a beautiful canyon and the tinajas, where we found nine specimens of *Hyla regilla* for Jameson. They sang in the plastic bags as we hiked back to the boats in the dusk.

Díaz had arranged for goats to be barbecued for a party on shore. Mr. Pedro Mayu, owner of Puerto Escondido, and his son Pierre had arrived from Hermosillo with several Mexican guests. Captain and Mrs. West of the yacht "Monsoon II", with their guests Mr. and Mrs. Joe Kelly, also joined the party, which was very pleasant.

April 8: Puerto Escondido to Isla Monserrate.

Departing from Puerto Escondido at 0600, we reached Isla Monserrate an hour and a half later and anchored near its southwest corner. Monserrate is 4 miles long and 2 miles wide, with a highest elevation of 734 feet. Though most of the island is composed of volcanic rock, there are Middle Pliocene fossiliferous limestone deposits at the beach, and more grey limestone caps the mesa at about 600 feet elevation.



FIG. 18. George Lindsay with a giant barrel cactus (*Ferocactus diguetii*) on Isla Santa Catalina. The giant cacti in the background are cardons (*Pachycereus pringlei*).



FIG. 19. Michael Soulé with one of the rattlesnakes (*Crotalus catalinensis*) of Isla Santa Catalina.

Moran and Harbison were on the island all day, while the rest came aboard at noon for lunch. Moran went to the top of the island and to the northern edge of the limestone mesa. Wiggins found a spicy-scented succulent composite with only one flower per head (*Coulterella capitata*); it was previously known only from a limited area near La Paz and from the four southernmost islands. Emerson, Wiggins, and Díaz went about halfway up the west coast of the island in a small boat and found some fine specimens of Pleistocene sand dollars.

Vegetation was rather dense in some arroyos and made travel inland difficult. Many specimens of *Peniocereus johnstonii*, a thin-stemmed cactus with huge tuberous roots, were found, one with stems nearly ten feet long and a tuber that would weigh more than fifty pounds. Another cactus seen was *Wilcoxia striata*, called jaramatraca by Baja Californians, which has dahlia-like tubers and stems thinner than a pencil.

A south wind blew all afternoon, so we anchored off the north end of the island for the night. Harbison stayed ashore. Shaw and Soulé worked some sand dunes with lanterns after dark. Soulé caught a banded burrowing snake and had another in his hand, as well as several joints of cholla cactus. He had tracked the snake over the dunes, made a grab for it, and got snake and cholla at the same time — but the snake hit the sand, submerged, and “swam” away.

It was windy during the night. Wiggins and Lindsay were up from time to time, securing things on deck so they would not blow overboard.

April 9: Isla Monserrate to Isla Santa Catalina.

We arrived at Catalina at 0830 and anchored in a cove about midway on the west side of the island. Catalina is a rugged island, about 7½ miles long, 2 miles wide, and 1500 feet high, surrounded by deep water. The bottom at the anchorage was deep and steep, so we arranged for everyone to be aboard by 1600 in order to find a more secure place for the night. Catalina is the type locality of a ponderous barrel cactus (*Ferocactus diguetii*), often more than ten feet tall. These yellow-spined giants, mixed with clean-looking cardon cacti (*Pachycereus pringlei*), give the island an unusual appearance. In the arroyos near the beach the *Burseras*, *Machaerocereus*, and other plants formed dense thickets. One could often see half a dozen iguanas (*Dipsosaurus catalinensis*) under a single bush, and the utas (*Uta squamata*) were blue-green. Moran found a rattlesnake and complained that it did not rattle, although it shook its tail. It had no rattle and was thought to be an anomaly, but in the afternoon Emerson found another, also without a rattle. The snake was *Crotalus catalinensis* which was described from a single specimen in 1954. All three of the known specimens of *C. catalinensis* lack rattles. A spotted night snake (*Hypsiglena*) taken under a rock was a new record for the island.

The biologists returned to the ship at 1615, and we went to the north end of the island, where the chart showed a bright and sand beach between two headlands. It was very windy, and there was no light or protection. Catalina has not been surveyed, and the chart is inadequate. We returned to a small cove on

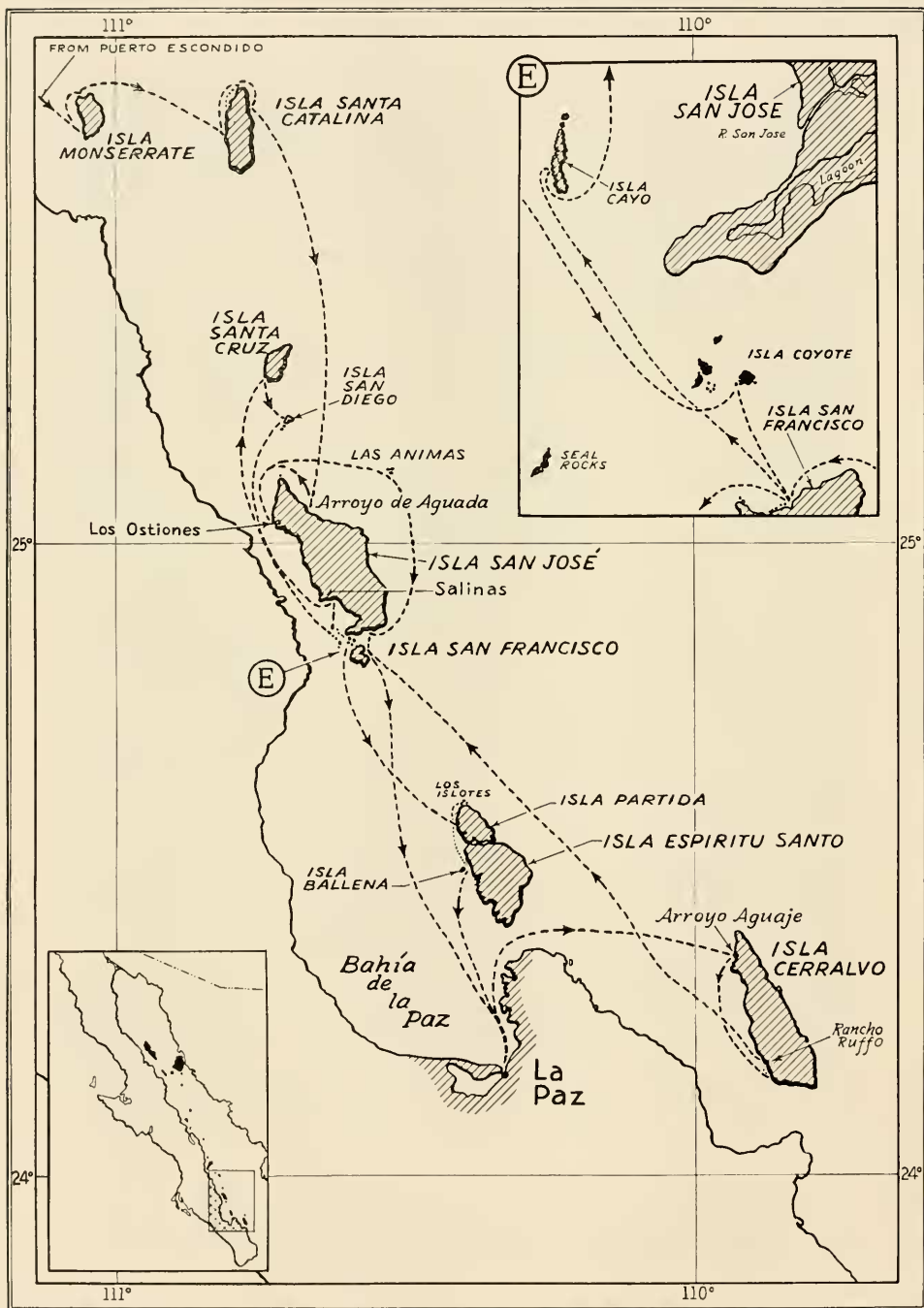


FIG. 20. South Gulf islands, the route of the expedition shown by a dash line.

the northwest side where we had fair protection. Banks, Harbison, and Moran went ashore. Wiggins and Lindsay fished with Juan Largo in a small boat, catching several large yellowtail. Then a fish struck Lindsay's outfit, taking it out of his hands and overboard. The night was uncomfortable, with heavy roll.

April 10: Isla Catalina

The ship was moved to a rock-and-sand spit on the northeast side of Catalina. A canyon south of the spit contains a small spring and a grove of date palms, which were visited by Moran, Harbison, and Soulé. Moran went south on the main ridge to the highest point on the island, about 500 meters by altimeter. The east side of the island was sterile compared with the west side, and most of the biologists spent the afternoon aboard, working on their collections. A cold wind came up at dusk. The small boats were put aboard, and the ship moved as close to shore as was deemed safe, in order to secure as much protection as possible in the lee of the spit. There was considerable motion during the night.

April 11: Isla Catalina to Isla San José.

The engines started at 0410, but there was some difficulty in getting the anchor unfouled. We departed for Isla San José about 0500. San José is 16½ miles long, 2 to 6 miles wide, and 2000 feet high. It is also composed of Comondú volcanics overlaid by deposits of marine Pliocene. We anchored on the northeast side, at Arroyo de Aguada, at 0930. Emerson found tremendous deposits of middle or early Pliocene pectens and oysters in a remarkable state of preservation. The beds were more than 150 feet thick. The gastropods were casts, the shells having leached away.

There was a single date palm in the arroyo bed at Aguada, and a deserted goat ranch. Antero Díaz and José Toledo went hunting and saw two deer but did not shoot. Emerson worked the fossil deposit and was joined by Wiggins in the afternoon. Harbison found a speckled rattlesnake (*Crotalus m. mitchelli*), which Soulé collected. Scorpions were small and of at least two species. The biologists were aboard at 1600 and the ship moved to Los Ostiones, a lagoon enclosed by a sand spit on the northwest side of San José, where there is protection from north winds. Banks set mammal traps after dinner, using a flashlight, and Harbison spent the night on shore.

April 12: Los Ostiones, Isla San José, to Isla Las Animas and Isla San José.

Soulé was anxious to sample the herpetofauna on the Baja California peninsula adjacent to San José, so Juan Largo took him to Puerto Nopalo, where he found a goat ranch and a Mexican family with many children. The other biologists worked the mountains behind Los Ostiones. The country was largely granitic but also had fossil deposits. Two rattlesnakes were taken (*Crotalus ruber lucasensis* and *C. e. enyo*), which with the *C. mitchelli* collected the day before make a total of three species for San José. A spotted night snake was collected under a fallen cardon.



FIG. 21. Whitewashed Isla Las Animas, where cacti predominate. In the foreground, thick-stemmed *Machaerocereus gummosus* and smaller, creeping *Cochemia poselgeri*. Also, *Opuntia cholla* and *Atriplex barclayana*.

Antero Díaz and José Toledo went hunting early, returning with a nice buck deer at 0900. It was very dark but probably the same subspecies (*Odocoileus hemionus peninsulae*) found on the peninsula. The skull and hide were preserved by Banks for a specimen.

We departed for Isla Las Animas at 1015. The sea was calm, and we saw many mantas, sharks, yellowtail, trumpetfish, and sierra in the clear water as we crossed a shoal area off the north point of San José.

Las Animas is a barren granite rock a few hundred yards long and perhaps 150 feet high, with a few offlying rocks and surrounded by very deep water. The ship stood off while the biologists went ashore, probably the first "biological survey" the islet has experienced.

We were surprised to find two kinds of lizards, one possibly *Urosaurus microscutatus* and the other *Phyllodactylus tuberculatus*, and several scorpions (*Vejovis* sp. and *Centruroides exilicauda*), were also taken, under rocks. Pelicans were nesting; and man-of-war birds wheeled overhead, but none of their nests were seen. Only ten kinds of flowering plants were observed, six of which were cacti, *Pachycereus pringlei*, *Machaerocereus gummosus*, *Lemaireocereus thurberi*, *Cochemia poselgeri*, *Opuntia cholla*, and *Mammillaria albicans*. The

others were *Atriplex barclayana*, *Perityle robusta*, *Portulaca pilosa*, and *Trianthema portulacastrum*. California sea lions inhabited rocks just east of the island, and a dead one was floating in the water, surrounded by an oil slick fifty yards across, presumably from the decomposing animal.

Aboard again at 1345. we had lunch en route to the south end of Isla San José. There we anchored off the base of the rock spit enclosing the southernmost lagoon. Díaz came ashore and shot a ring-tailed cat (*Bassariscus astutus*) in a mangrove thicket. The lagoon had many oysters and large puffer fish.

April 13: Isla San José to Isla San Francisco and La Paz.

Wiggins, Moran, Shaw, Soulé, and Lindsay went to Isla San Francisco in the 15-foot boat, while the ship waited for Banks to pick up his traps and to take Harbison aboard. San Francisco, lying about $4\frac{1}{2}$ miles south of San José, is an irregular island with an area of about $1\frac{1}{2}$ square miles and an altitude of 689 feet. It was very dry, and even the cacti showed drought distress. We found emaciated specimens of the southern chuckwalla (*Sauromalus ater*) and a few other reptiles.

The ship arrived at 0900, and we boarded and proceeded to La Paz, arriving at 1600. It was Good Friday afternoon and rather difficult to locate the port officials, but in due time we had permits to take fuel and water on Saturday morning and received accumulated mail from the Captain of the Port. Dinner was at the Perla Hotel to give Rosario, our cook, a well-deserved rest.

April 14: La Paz

The ship was watered, fueled, and provisioned. Don Hunsaker II, an Assistant Professor of Zoology at San Diego State College, Dennis Bostic, a graduate student, and Chris Parrish, a museum assistant and student at San Diego State College, arrived by plane at 1800, to join the expedition during their Easter holiday.

April 15: La Paz to Isla Cerralvo.

The engines started at 0400, and we were under way soon after. The yachts in the quiet bay and the lights in the backdrop of the town were beautiful. We passed several ships in the La Paz and San Lorenzo Channels and arrived at Arroyo Aguaje, on the northwest side of Cerralvo, at 0900.

Isla Cerralvo — the name is also spelled "Ceralbo" — is 16 miles long and $4\frac{1}{4}$ miles wide. It has several high peaks, one of which, about 7 miles from the north end of the island, is 2518 feet high. The island is a single mountain range, composed of coarse greenish-white granitic rock, with some metamorphosed sediments. Its vegetation is heavier than that of the other Gulf Islands and resembles that of the lower areas of the Cape region of Baja California.

We found two small springs in the arroyo, shaded by giant fig trees (*Ficus palmeri*). The spring water was potable but had a sweet taste. Damsel flies were mating and depositing eggs. There were many cardinals and woodpeckers.



FIG. 22. Richard C. Banks with a live fish-eating bat (*Pizonyx vivesi*) collected on Isla Cayo.

Boarding at 1500, we cruised to the southwest corner of the island and anchored just north of a sandspit which gives protection. All went ashore and worked sand dunes until dark.

Soulé, Hunsaker, and Bostic were particularly interested in *Sator*, a genus of primitive lizards found only on Cerralvo, Santa Cruz, and San Diego Islands. The itinerary of the expedition was adjusted so that Hunsaker and Bostic could visit these three islands during their limited time in the field during their spring holidays. Several living specimens of *Sator grandaevus*, which occurs only on Cerralvo, were collected for subsequent behavior studies in the laboratory and for the San Diego Zoo. Hunsaker and Bostic spent the night on shore, as did Harbison. Soulé and Parrish also collected by lantern light, returning to the ship about 2000.

April 16: Isla Cerralvo.

Moran, Wiggins, and Emerson wanted a full day at the arroyo at Rancho Ruffo and were taken there in a small boat while the rest of the biologists worked the sand dunes and arroyo at the anchorage. Hunsaker and Bostic did not come aboard for breakfast but spent the morning collecting sators. The animals showed four distinct color phases. One female had a bright orange head. The ship moved to Rancho Ruffo at noon. Emerson had worked a fossil deposit in the morning and continued in the afternoon, accompanied by Wiggins. Moran came to the beach at dark, after an all-day hike to the top of the island. The vegetation was dry, but the giant barrel cacti, *Feroactus diguetii*, were in bloom. Parrish collected scorpions, six species of which were taken, collected lizards, and shot a canyon wren for Banks.

April 17: Isla Cerralvo to Islas San Francisco and San José.

The crew was up before 0400 and picked up Harbison from the shore, where he had spent the night, and we were under way north at 0430. We cruised past the east side of Isla Espíritu Santo and Isla Partida. The Gulf was flat and glassy. At one place we changed course to follow a pod of about 12 pilot whales. A Ridley sea turtle was speared by Juan Largo and the specimen saved because it has only rarely been taken in the Gulf. We observed many dolphin fish, manta rays, and marlin.

The short stop at the isthmus of Isla San Francisco on April 13th did not provide sufficient time to work that island, and in passing we had observed a mangrove lagoon at the north end. Moran suggested that an additional stop be made there, so we went ashore from noon until 1500. The vegetation, though dry, was in better condition than that at the isthmus. Also the scorpion collecting was much better. On the previous stop only one kind was found, but on this stop the known fauna was increased to 6 species. Proceeding toward the west side of Isla San José, we passed Isla Coyote, with a picturesque group of fishermen's houses snuggled at the base of rock bluffs, and approached Isla Cayo. This



FIG. 23. Isla Santa Cruz as seen from Isla San Diego.

is a small rocky ridge which we decided to visit. Moran, Wiggins, Banks, Hunsaker, Parrish, Bostic, and Lindsay landed. Four fish-eating bats were taken from crevices in the rocks, Hunsaker smoking them out with cigar smoke. Great blue herons, black-crowned night herons, brown pelicans, cormorants, and boobies were on the islet and offlying rocks. Bostic and Lindsay collected several scorpions (*Broteas alleni*) and *Urosaurus* and *Phyllodactylus* lizards. The very short stop was interesting and productive.

We anchored for the night at the salt works on the southwest side of Isla San José. Several went ashore and visited the small village and the ponds, where the salt is harvested by hand. About 25 laborers work there. Wild goats and deer are a principal food in their rather primitive mess. A compact raft of eared grebes passed near the boat — perhaps 500 birds in the mass, all diving in unison, then popping to the surface.

April 18: Isla San José to Islas Santa Cruz and San Diego.

We made another 0430 departure, for Isla Santa Cruz, where we anchored off the southwest corner at 0800. Santa Cruz is a steep rugged granitic island, $3\frac{3}{4}$ miles long, about $1\frac{1}{2}$ miles wide, and 1500 feet high. Bold bluffs 300 to 1000 feet high make it inaccessible except on the west side, where there are steep arroyos and the slopes are about 45 degrees.

The biologists were soon ashore, and Moran found a rattlesnake (*Crotalus atrox*) a few minutes after landing. Parrish collected another almost immediately. Three species of lizards were the only reptiles recorded from the islands, so the rattlers were of particular interest, but no others were found. The second known species of sator lizard (*Sator angustus*) was very common and tame. One cardon cactus was in flower, with a sator stationed beside each blossom, eating the insects that it attracted. Using a trout pole and noose, Shaw captured all of the lizards on the plant. Then while resting for a few minutes, he observed another crop of sators climbing the same cactus to take stations beside the open flowers. They, too, were collected.

A group of approximately 60 harbor porpoises swam north past the anchored ship and returned, in scattered bunches, later in the day. One blackfish went through express, traveling at about six knots and swimming about 150 feet between breaths.

Moran went up a steep arroyo to the summit of the island. A few plants of *Ferocactus diguetii* were observed.

We moved to tiny Isla San Diego at 1600. This, too, is a granitic island, about one mile long and 722 feet high. We anchored off the southwest shore, and had an hour's collecting before dark.

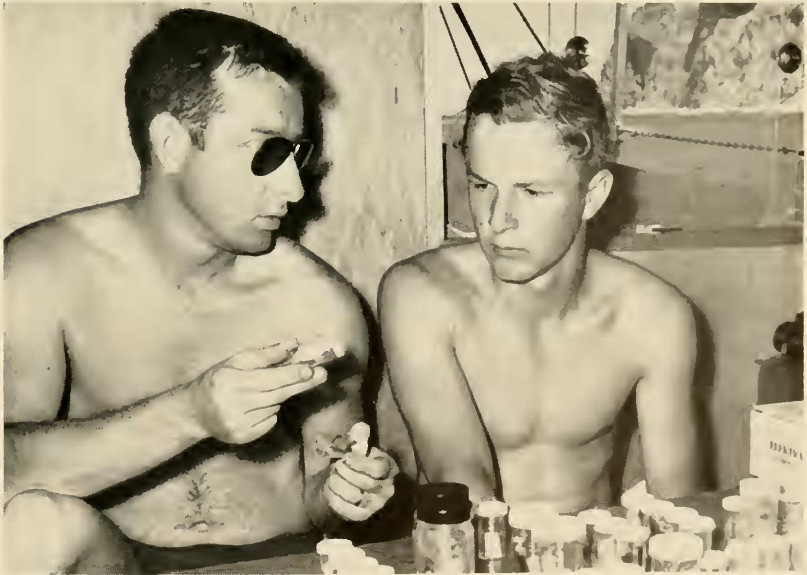


FIG. 24. Don Hunsaker and Chris Parrish with some of the 270 scorpions collected on the expedition.



FIG. 25. Music at Banks's birthday party, off Isla San Francisco.

April 19: Isla San Diego to Islas Coyote and San Francisco.

Banks had traps ashore and caught 11 deer mice (*Peromyscus sejugis*). Moran was ashore before breakfast, to have all available time on the island. The other biologists were ashore at 0630 and collected until noon. Emerson got a fine series of a land snail (*Bulimulus chamberlini*) previously known only from one imperfect specimen. A white globular cactus (*Mammillaria albicans*) was particularly abundant. Hunsaker and Parrish dove for fish and invertebrates. When they were picked up, a group of harbor porpoises accompanied the small boat.

We departed at noon, cruising down the west side of Isla San José and stopping at the fishing village on Isla Coyote to inspect a mechanical device which the fishermen had found floating near Las Animas. This was a deep-sea free vehicle, with a fish trap attached, which had been released from the California Fish and Game vessel "Alaska" in March and not recovered. Its radar reflector, buoyancy floats, and trap had puzzled the fishermen.

Isla Coyote, known locally as Partida, is inhabited by one large family. The head of the house has 24 children. The barren islet also produces two kinds of lizards, *Uta* and *Phyllodactylus*, and two species of scorpions (*Broteas alleni* and *Centruroides exilicauda*).

We anchored for the night at the north end of Isla San Francisco. Banks went ashore to set mammal traps; and while he was gone, Antero Díaz prepared a birthday party for him. Impromptu gifts, doggerel, and songs made an entertaining evening. Antero had sent a boat to Coyote for a guitar, and the crew serenaded Banks with appropriate birthday songs.

April 20: Isla San Francisco to Islas Partida and Espíritu Santo.

We cruised to the first bay on the northwest side of Isla Partida. Soulé took a small boat to Los Islotas, a group of rocks off the north end of the island, and found a *Urosaurus* lizard and a scorpion (*Broteas alleni*). The other biologists went ashore on Isla Partida.

Isla Partida and Isla Espíritu Santo are separated by a narrow strait which can sometimes be navigated with a canoe. Partida is about $3\frac{1}{4}$ miles long, and Espíritu Santo is $7\frac{1}{2}$ miles long, 2 to 5 miles wide, and nearly 2000 feet high. The islands are composed of lavas, mudflows, tuffs, and other eruptive rocks of the Comodú age, dipping 8 to 10 degrees westward. There are several deep indentations along the west sides of the islands, and there are three offlying islets. The eastern sides of the islands are great bluffs of banded rocks.

We departed at 1500 and cruised south to anchor in a cove at Isla Espíritu Santo, just opposite Isla Ballena. All were ashore from 1600 until dark. José Toledo shot two of the black jackrabbits (*Lepus insularis*) that are known only from Espíritu Santo. These are large hares with black backs and cinnamon underparts. Soulé shot a *Uta* and when he retrieved it from a bush he found he had also killed a rattlesnake! Wiggins also took a rattler while tearing a fallen cardon apart. Both were *Crotalus mitchelli mitchelli*. Parrish collected many scorpions, and surprised himself by shooting a flying bat (*Pipistrellus hesperus australis*) with his 22-caliber dust-shot pistol. Hunsaker and Bostic made an industrious assault on the island, tearing up dead cardons, turning boulders, and otherwise altering the landscape in their search for reptiles.

Espíritu Santo was much more interesting than Isla Partida. There was heavy vegetation in the arroyo. Harbison stayed ashore all night. Hunsaker joined him about 2100, after preparing one of the rabbits for Banks.

April 21: Isla Espíritu Santo, Isla Ballena, and La Paz.

Banks found two woodrats (*Neotoma lepida vicina*) in his traps when he went ashore. Moran also went ashore without breakfast, in order to have as much time as possible on the island, and climbed to the cliffs at the head of the main canyon. Wiggins, Emerson, Hunsaker, Bostic, Parrish, and Lindsay spent two hours on Isla Ballena, a small island about $\frac{3}{4}$ mile long, $\frac{1}{4}$ mile wide, and 228 feet high. Agustin Toledo picked the group up at 0930, dropped Hunsaker, Bostic, and Parrish at the boat, and took Wiggins, Emerson, and Lindsay to the main island for further collecting. All were back aboard at 1145, and we went to La Paz, arriving at 1500.

Hunsaker, Bostic, and Parrish had reservations to fly to Tijuana on April 23rd. The collecting activity of the expedition was completed, and we tried to make reservations for several of the other biologists to return on the same plane, but there was no space available. Therefore we radio-phoned Francisco Muñoz and arranged for his Cessna 195 to meet the ship at Loreto on Wednesday, April 25th. Most of the scientific crew spent the night ashore.

April 22: La Paz, Easter Sunday.

This was a quiet day of rest and recuperation. Mr. Albert E. Schwabacher of San Francisco kindly allowed us to use his radio for some necessary traffic with the United States and invited several of the scientists aboard his yacht "Pez Espada V" for cocktails in the late afternoon.

A dinner for the biologists at La Perla Hotel celebrated Chris Parrish's birthday and the successful completion of the collecting activities of the expedition.

April 23: La Paz and north.

Hunsaker, Bostic, and Parrish departed by plane for Tijuana. It was impossible to get water and fuel, but we had sufficient supplies of both to reach Bahía de los Angeles so departed for the north at 1400. We ran through the night and had calm seas. The bioluminescence was spectacular. Flying fish flashed light, then great balls of small fish spread like an exploding rocket. Occasional glows deep down probably indicated sharks.

April 24: Enroute, La Paz to Bahía de los Angeles.

Daybreak light at 0430 silhouetted Isla Monserrate and played on Isla Danzante and the Sierra Giganta behind Puerto Escondido. We stopped at Puerto Chenque for an hour, while Díaz went ashore, and then at Loreto. There a telegram was sent to Muñoz revising our rendezvous to Santa Rosalía. We had a short visit with Miss Annetta Carter and departed for Santa Rosalía at 0930.

The biologists enjoyed a day of relaxation, caught up on their reading and specimen preparation, and made preliminary reports of their field results. After dark, the bioluminescence was particularly beautiful. We passed to the east of Isla San Marcos, picked up the lights of Santa Rosalía, and anchored in its harbor at 2200.

April 25: Santa Rosalía, enroute to Bahía de los Angeles.

The "San Agustín II" was tied up to the dock for water at daylight. The Cessna 195 buzzed the ship at 0600; and Emerson, Soulé, and Banks met the plane at the hillside airport and departed for Tijuana. The crew did considerable personal shopping at Santa Rosalía, and we finally left for Bahía de los Angeles at 1130. There was more chop than we had experienced for several days, and it became rough after dinner. Jackets were broken out of sea bags for the first time in a month.



Fig. 26. Antero Diaz, owner of the "San Agustín II" and our genial and efficient host on the expedition.

April 26: Bahía de los Angeles.

We arrived at Bahía de los Angeles at sunrise, 0500, in heavy wind, and breakfasted aboard because the chop made it too wet to go ashore. The ship was unloaded in a surprisingly short time: all of the collections and gear were on the beach by 0800. Carl Hubbs and a party from Scripps Institution of Oceanography were at the Vermilion Sea Field Station, making a survey of the fish fauna of the bay. The research vessel "Traveler", with J. Laurens Barnhard and party from the Beaudette Foundation, were engaged in a benthic survey of the same area. There was much scientific activity connected with the field station.

Collections were sorted. Wiggins and Moran loaded the International Travelall of the Belvedere Scientific Fund with the dried plant specimens, Banks's birds and mammals, and Harbison's insects, and departed for the north at 1300. The fossils, preserved reptiles, living cacti, and other heavy specimens were packed for shipment to Tijuana by truck. Harbison, who had left a jeep at the station some months earlier, had it prepared for the return trip. Shaw and Lindsay left by plane with Muñoz at 1450, arriving at Tijuana at 1700.

PRELIMINARY REPORT OF THE SCIENTIFIC COLLECTIONS

The Belvedere Expedition was a success; and I am confident that, when its scientific results are known, it will compare favorably with the "Albatross" expedition of 1911 and the "Silvergate" expedition of the California Academy of Sciences in 1921. This can be only a preliminary sketch of what was accomplished.

BOTANY

Dr. Ira L. Wiggins, Professor of Botany at Stanford University, and Dr. Reid Moran, Curator of Botany at the San Diego Natural History Museum, were the botanical collectors. Altogether, they made nearly 2000 numbered collections of vascular plants. Since they collected independently, there were duplications; however, each found many plants not seen by the other, and the total collection is thus greater.

Although half a dozen botanists have at one time or another visited one or more islands in the Gulf, the only one to visit all of the principal islands and to report on the flora of the area was Ivan M. Johnston, who was with the California Academy expedition of 1921. Dr. Johnston was an extremely able field man and taxonomist and wrote an excellent report. However, he simply did not have time to cover some of the larger islands; and furthermore, the trip was too early for the summer annuals and too late for many of the spring annuals. Therefore, many plants remained to be found.

Johnston observed that, whereas various of the islands have endemic reptiles and mammals, they have few endemic plants. Although several species were first described from insular material, most of them have turned up later on the adjacent peninsula. Johnston explained the much lower degree of endemism among plants as probably resulting from their greater powers of overwater dispersal, with consequent greater likelihood of swamping out of incipient endemism. Botanically, one might say that the Gulf islands are not so much islands as detached bits of the mainland and peninsula: the flora of each island seems to include just about every plant of the adjacent land for which there is a suitable habitat. Perhaps for this reason, Johnston, who collected also at many stations on the peninsula and mainland and wrote of the flora of the Gulf region as a whole, did not emphasize the floras of the individual islands. For various of the widespread species, he made no attempt to list each station at which he saw each plant.

On this trip, Drs. Moran and Wiggins placed more emphasis on the floras of the individual islands. They carried ashore on each island a list of the plants previously reported, and made a special effort to collect those plants not listed. As a result, many widespread plants were collected which otherwise might have been overlooked on the assumption that they must have been reported before. Various unexpected plants were also found, some of them apparently representing considerable range extensions. On some islands many species were added



FIG. 27. Charles F. Harbison camped ashore for insect collecting by lantern light.

to the poorly known flora; an extreme example is Danzante Island, where only about 30 species were definitely reported and about 80 additional ones were collected on our trip.

The specimens collected on this trip not only amplify the lists of species known from the various islands but also give valuable information about the total range of species in the Sonoran Desert, whose detailed distribution has been poorly known. It is possible that some of the specimens that could not be identified in the field represent species as yet undescribed.

Dr. George Lindsay investigated the cactus flora of the islands in connection with a current study of the Baja California representatives of that family. He collected many living plants, of which some were later prepared as herbarium specimens and others were grown for information about their flowers.

ENTOMOLOGY

Mr. Charles F. Harbison, Curator of Entomology of the San Diego Natural History Museum, collected about 10,000 arthropods, including insects, spiders, ticks, scorpions, pseudoscorpions, and centipedes. Harbison was an enthusiastic and energetic collector, turning innumerable rocks, wielding his net wherever the spiny vegetation would permit, and camping ashore at night to collect by lantern light.

Many insects known from the Baja California peninsula can now be recorded from the Gulf islands for the first time. The insect material, when worked up by specialists, will be a valuable contribution to the knowledge of the entomofauna of the area.

Chris Parrish, a young research assistant with the San Diego Natural History Museum and a student at San Diego State College, was with the expedition for eight days. Parrish has a large collection of scorpions from the Baja California peninsula. During the expedition some 270 specimens of about 14 species in 7 genera were collected by or for him on the Gulf islands. These may well prove to be of particular interest.

BIRDS AND MAMMALS

Dr. Richard C. Banks, Curator of Birds and Mammals at the Natural History Museum, was in charge of collections of these animals. He prepared 77 bird and 98 mammal specimens, ranging in size from hummingbirds to deer. Skulls of marine mammals picked up on beaches and saved as locality records are not included in the above count.

There is a high rate of endemism in the mammals of the Gulf islands, particularly among the mice and rats. Of the forms taken on this trip, 29 are new to the Museum's collection. Range extensions were established for two species. Little information about breeding time, litter size, or habitat selection is published for the insular mammals, and many data were accumulated on this expedition.

The distribution of birds on the islands is not well known, so the specimens and sight records obtained add much distributional information. Most of the species recorded, however, are of widespread distribution. Few insular populations of birds are recognized as taxonomically distinct; but four new forms were added to the Museum's collection, all from Tiburón Island. Many data on breeding were accumulated, especially for the colonial sea birds.

The information upon bird distribution obtained on this trip complements Dr. Banks' current detailed study of the birds of Cerralvo Island.

REPTILES

There are many species of reptiles on the Gulf islands. The diversity of reptiles and the large number of islands combine to furnish the biogeographer and evolutionist with examples of the effects of isolation, restriction of area and habitat, and presence or absence of predators and of other species of reptiles, as well as offering many clues to the history of the herpetofaunas of Baja California and western North America.

Mr. Charles Shaw, Curator of Reptiles of the San Diego Zoo, and Mr. Michael Soulé, of Stanford University, were responsible for the reptile collecting, but all of the biologists participated. Dr. Hunsaker and Mr. Bostic, of San Diego State College, made behavioral studies, in addition to collections for the Museum.

Mr. Soulé took more than 100 serum samples for electrophoretic and immunological analysis.

The large number of specimens from the islands is an important addition to the Museum's reptile collection. Approximately 15 new records for the islands were discovered, some of which doubtless represent undescribed taxa. The herpetologists also collected many live lizards for display in the San Diego Zoo and for behavioral studies.

Dr. Hunsaker and Mr. Bostic were particularly interested in the behavioral differentiation of two species of the primitive lizard genus *Sator*, which occupy separate islands and have been isolated probably since Pliocene and possibly since Miocene times. They made observations and took motion pictures to show the behavior of the two. Also, they took a large sample of living sator lizards for laboratory studies.

INVERTEBRATES

Dr. William K. Emerson of the American Museum of Natural History collected fossil and Recent invertebrates, mostly mollusks. He took fossils, ranging in age from early Pliocene to late Pleistocene, at fourteen different localities, several of which were previously unknown. The collections include critical material that will establish the precise age of several poorly known deposits.

Dr. Emerson collected Recent mollusks from the intertidal zone at thirty-five localities. This material will greatly aid in establishing the distribution of the molluscan fauna within the Gulf. He also collected invertebrates from kitchen middens on some of the islands.

An extensive series of land shells was taken from the islands by Emerson and other members of the scientific party. This material is expected to be of considerable zoogeographical interest.

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The scientific collections were made with the permission of various officers and officials of Mexico. The generous cooperation and help of the following gentlemen is particularly appreciated. Marine collections were made under permits granted by C. Almirante Antonio Vázquez del Mercado, Director General de Pesca de Industrias Conexas, de la Secretaría de Industria y Comercio. C. Dr. Enrique Beltrán, Subsecretario de Agricultura y Ganadería, personally arranged for permits to collect plants and for additional courtesies from his offices. C. Ing. Luis Macías Arellano, Director General de Caza de la Secretaría de Agricultura y Ganadería, issued the permits for taking land animals.



FIG. 28. William K. Emerson with a dwarf cardón (*Pachocereus pringlei*) on Isla Santa Catalina.